STRUCTURAL MODELLING OF COST OVERRUN FACTORS IN CONSTRUCTION INDUSTRY

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DEDICATION

For my beloved father and mother
who had the arduous task of raising incorrigible children's by them.

To my wife, children and siblings who supported me in all my endeavours

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ABSTRACT

Construction industry contributes significantly in improving socio-economic growth of a country. However, this industry usually faces chronic problems such as time overrun, cost overrun, poor quality and others. Of all these, cost overrun is a major problem that occurs globally including Malaysia. Cost overrun is resulted from various factors which are essential to identify for improving cost performance in construction project. Hence, this study focused on identifying and modelling the factors of cost overrun for construction projects in Malaysia. Data collection was done through structured questionnaire, which was designed based on 78 factors found from the literature. Qualitative pilot study was done based on the opinions of 15 experts in the construction industry to improve the questionnaire by reducing the factors to 58. The questionnaire survey was carried out among clients, consultants and contractors. A total of 231 questionnaires were collected of which 213 responses were found valid. Partial Least Square Structural Equation (PLS-SEM) model was developed based on 8 categories/constructs generated through factor analysis test and found that Global Fit Index (GOF) of the model to be 0.37. The findings from the model indicate that all the 8 categories have significant effect on the cost overrun. The most significant category is contractor's site management related issues with path co-efficient value of 0.448. The developed model was validated statistically (using power analysis and predictive relevancy) and through interviewing 21 experienced practitioners. Statistical validation tests showed that the developed model had achieved substantial power in explaining cost overrun problem. All the experts agreed with the factors and also categories of the model have significant impact to cost overrun.

ABSTRAK

Industri pembinaan menyumbang secara ketara dalam meningkatkan pertumbuhan sosio-ekonomi sesebuah negara. Walau bagaimanapun, industri ini sentiasa menghadapi pelbagai masalah kronik seperti lebihan masa, lebihan kos, kualiti yang rendah dan lain-lain. Dari semua ini, lebihan kos adalah masalah utama yang berlaku di seluruh dunia termasuk Malaysia. Lebihan kos adalah hasil dari pelbagai faktor yang penting untuk dikenal pasti bagi meningkatkan prestasi kos dalam projek pembinaan. Oleh itu, kajian ini mengfokuskan kepada mengenal pasti faktor serta membina model lebihan kos untuk projek pembinaan di Malaysia. Pengumpulan data dilakukan melalui borang soal selidik berstruktur yang direkabentuk berdasarkan 78 faktor hasil kajian literatur. Kajian rintis berbentuk kualitatif dilaksanakan berdasarkan pendapat 15 pakar dalam industri pembinaan bagi memperbaiki borang soal selidik dan hasilnya bilangan faktor menjadi 58 sahaja. Soal selidik sepenuhnya dijalankan di kalangan klien, perunding dan kontraktor. Sebanyak 231 borang soal selidik telah dipulangkan dan hanya 213 borang adalah sah. Model *Partial Least Square Structural Equation (PLS-SEM)* dibangunkan berdasarkan 8 kategori / konstruk dijana melalui ujian analisis factor dan didapati Global Fit Indeks (GoF) model tersebut adalah 0.37. Penemuan menunjukkan bahawa semua 8 kategori mempunyai kesan ketara terhadap lebihan kos. Kategori yang paling ketara adalah isu berkaitan pengurusan kontraktor di tapakbina dengan nilai angkali 0.448. Model yang dibangunkan telah disahkan melalui statistik dan melalui temuramah dengan 21 pakar pembinaan yang berpengalaman. Pengesahan statistik menunjukkan model yang dibangunkan telah mencapai kuasa yang ketara dalam menjelaskan masalah lebihan kos. Semua pakar bersetuju bahawa faktor dan kategori yang terdapat dalam model mempunyai impak yang ketara terhadap lebihan kos.

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CHAPTER 1

INTRODUCTION

1.1 Background

Construction industry is a very important industry that plays a vital role in the socio-economic growth of a country. Economically, it contributes significantly in the improvement to the overall GDP of a country. It also improves the quality of life by providing necessary infrastructure such as roads, hospitals, schools and other basic and enhanced facilities. Hence, it is fundamentally crucial to make the construction projects complete successfully within the time, budget and quality expected. However, being a complex, fragmented and schedule driven industry it is always facing chronic problems such as low quality, low productivity, cost overrun, time overrun, construction waste etc. Of these, cost overrun is the major problem as money is always of high importance.

Cost overrun is a global phenomenon in the construction industry and very rarely projects are finished within the budgeted cost. The issue of cost overrun in construction projects is very dominant in both developed and developing countries but this trend is very severe in developing countries where these overruns sometimes exceed 100% of the anticipated cost (Azhar, Farooqui, & Ahmed, 2008).

Flyvbjerg, Holm, & Buhl (2003) in their global study of construction project performance concluded that cost overrun is a major problem in the construction industry where 9 of 10 projects are faced by these overruns which commonly range between 50 to 100%. In developed countries like UK also construction industry is affected by this problem (Olawale & Sun, 2010) and nearly one third of the client's complaint that their projects generally overran the allocated budget (Jackson, 2002).

1.2 Problem Statement

Like other developing countries, Malaysia also facing a serious issue of cost overrun in construction industry (Ali & Kamaruzzaman, 2010, Sambasivan & Soon, 2007, Abdullah et al., 2009 and Ibrahim et al., 2010). This is confirmed with a research conducted by Endut, Akintoye, & Kelly (2009) showing that only 46.8% of public sector and 37.2% of private sector projects were completed within the stipulated budget. The issue of cost overrun has become a serious concern of the investors, which needs a serious attention and in-depth research to put forward with solution to this issue.

According to Toh, Ali, & Aliagha, (2011), Malaysia needs more research works by academia and practitioners regarding construction cost factors. Since construction cost is the most dominant component of project's life cycle, thus it is important to evaluate it before it is too late so that poor cost performance can be prevented (Cha & Shin, 2011). The impact of poor cost performance could lead to cost overrun which is an additional burden over the budgeted cost of project and this cost overrun can never be recovered. These overruns are resulted from various factors, thus it is important to identify and to control these responsible factors.

Further, there was no study done on assessing causal relationships among factors of cost overrun (Toh et al., 2011) and this give an opportunity to the author adopting Structural Equation Modelling (SEM) approach to assess and also to model the factors. SEM is a graphical equivalent of a mathematical representation (Byrne, 2010) with features of advance multivariate tool to determine the strength of the relationships between the factors (Jackson, Dezee, Douglas, & Shimeall, 2005; Hair, Anderson, Tatham, & Black, 1998). It is becoming very popular in analyzing cause–effect relations between factors (Hair, Ringle, & Sarstedt, 2011).

Hence, this study focuses on identifying major factors causing cost overrun run and developing a structural model in representing the factors affecting cost overrun for Malaysian construction industry.

1.3 Aim and Objectives

The aim of this study is to model the factors contributing to cost overrun in Malaysian construction industry. To achieve this aim, various objectives were set which include:

- Identifying the common factors causing cost overrun
- Assessing hieratically the causative factors of cost overrun in Malaysian construction industry
- Developing Structural Equation Model (SEM) to assess significance of causative factors to cost overrun
- Validating the results of SEM

1.4 Scope of the Research

This study adopted quantitative approach in identifying and assessing the significant factors causing overrun. The data samples are collected through questionnaire survey amongst the clients, consultants and contractors involved in construction industry. Contractors were selected from "list of approved contractors" in Construction Industry Development Board (CIDB) Malaysia registered under category from G3 to G7.

1.5 Research Methodology

This study is based on three research methods which include literature review, interviews and questionnaires. These three methods acted as supplement to each other which made the data collection more comprehensive and meaningful. Basically, literature review focused on gaining a better understanding of cost performance and causative factors affecting cost overrun in construction projects. These factors were analyzed in conformance to represent the problems of cost overrun in prevailing construction industry of Malaysia through interviewing the experience personnel

involved in handling construction projects. Questionnaire survey was conducted to understand the perception of clients, consultants and contractors towards the factors causing cost overrun. Gathered data was analyzed with statistical tools in order to draw the conclusion in determining the current situation of cost overrun problem and factors contributing to this overrun.

1.6 Thesis Layout/Organization

This study focused on modelling the causative factors of cost overrun to propose the guidelines for controlling cost overrun problem in construction industry of Malaysia. The thesis for this study is divided into 6 chapters as follows:

Chapter One: This chapter discusses about the need of this study. It contains background of the study and problem statement to outline the primary objectives, scope of the study with introductory remarks.

Chapter Two: This chapter contains the review of published research works for related study on cost overrun issues and factors of cost overrun.

Chapter Three: This chapter illustrates the methodology adopted for this study. It provides details of various analyzing approaches used for data analysis together with the data collection strategy used.

Chapter Four: This chapter explains the descriptive analysis results including the hierarchal assessment of causative factors of cost overrun and comparison of findings with similar studies carried out in other countries.

Chapter Five: It discusses the structural equation modelling (SEM) analysis and achieved results of causal relationships. It also explains the course of validating the results and prosing the mitigation measure and guidelines to help the practitioners in controlling causative factors of cost overrun at source.

Chapter Six: The final chapter discusses about the conclusion achieved from this study with counsel for probable advancement and line of action for future works to provide more benefits in achieving cost control of construction projects.

CHAPTER 2

LITERATURE REVIEW

2.1 Construction Industry in Malaysia

Construction industry is necessary in every country to provide physical developments which help in improving social and economic needs of country (Abedi, Mohamad, & Fathi, 2011). Hence, construction industry has been growing rapidly worldwide.

Construction industry in Malaysia developed since its independence. The industry is generally classified into two areas namely general construction and special trade works (Ibrahim et al., 2010). General construction focuses on residential and non-residential constructions and also general civil engineering works. For special trade works, the activities involved are metal works, electrical works, plumbing, sewerage and sanitary works, refrigeration and air-conditioning work, painting work, carpentry, tiling and flooring work, and glass work. Figure 2.1 and 2.2 show the example of construction work of apartment complex and tunnel construction in Kuala Lumpur.

Construction industry has been an important drive in Malaysian economy (Ali & Kamaruzzaman, 2010). However, the volatile global economy between 2008 and 2009 constituted an overall decline in revenue stream in Malaysia's construction market. It was a challenging period for the construction industry facing that economic crisis. According to (Rashid & Morledge, 1998) construction industry is considered in crisis if its growth is less than 5.4% of the Growth Domestic Product (GDP). Despite of these crises Malaysian construction industry has remained stable (Leung & Tam, 2004) and registered a strong growth of 5.8% in 2009. The industry

growth subsequently increased to 8.7% in 2010 as against that overall (GDP) growth of 10.1%. Realizing the huge impact on the economy, the government had allocated huge amount of the budget for construction development in Malaysia under 10th Malaysian Plan with a total sum of RM230 billion (Mansor, 2010).

Figure 2.1: Construction work on an apartment complex in Kuala Lumpur
Source: Richter & Scheid (2011)

Figure 2.2: The construction of the tunnel at Bukit Berapit in Kuala Lumpur
Source: Railway-Technology.com (2011)

In Malaysian construction industry, it is mandatory for the contractors to register with the Construction Industry Development Board (CIDB) before they are eligible to participate in any construction activities for both public and private

projects. A total of 66,904 contractors are currently registered with CIDB as classified in 7 categories ranging from grade G1 to grade G7 (CIDB, 2012) as shown in table 2.1.

Table 2.1: Contractors Registered under CIDB

State	Grade							Total
	G1	G2	G3	G4	G5	G6	G7	
Johor	3,320	1,075	1,314	320	309	123	333	**6,794**
Kedah	2,128	537	375	115	134	63	176	**3,528**
Kelantan	2,243	314	296	79	134	50	127	**3,246**
Melaka	1,118	376	392	128	126	43	110	**2,293**
Negri Sembilan	2,109	468	429	94	126	52	84	**3,362**
Pahang	2,193	500	557	185	152	59	128	**3,774**
Perak	2,677	634	641	178	178	71	123	**4,502**
Perlis	925	92	66	22	27	4	19	**1,155**
Pulau Pinang	1,405	635	774	141	230	95	287	**3,567**
Sabah	5,772	1,140	989	140	216	78	401	**8,736**
Sarawak	1,456	529	418	141	164	89	367	**3,164**
Selangor	4,536	1,277	2,251	574	816	283	1,005	**10,742**
Terengganu	2,286	333	356	147	209	76	165	**3,572**
Wilayah Persekutuan	1,823	870	2,325	529	1,106	368	1,448	**8,469**
Total	**33,991**	**8,780**	**11,183**	**2,793**	**3,930**	**1,454**	**4,773**	**66,904**

Source: (CIDB, 2012)

Table 2.1 shows that large group of contractors are in G1 grade which means that these contractors are entitled to participate in tendering for project with worth of maximum contract sum of not exceeding than MR 100,000. G2 contractors are suitable to participate in tendering for projects of contract sum not exceeding MR 500,000. Similarly, G3 and G4 contractors are qualified for tendering in project with maximum tender values of not exceeding than RM 1million and RM 3 million respectively. G5 contractors can participate in tendering process of project of value not exceeding than RM 5Million. Abdullah et al., (2009) stated that in Malaysia projects with contract value equal to or less than RM 5 Million are regarded as small projects. This means the contractors registered under grades G1 to G5 are eligible to

take part for tendering only in small projects. While, contractors registered in G6 and G7 grades are able to tender for small and large projects. However, grade G6 contractors are limited to tender up to RM 10 million project and G7 contractors have no limitation.

2.2 Problems in Construction Industry

Construction industry is considered as a locomotive of physical developments which bring substantial and significant impacts to the country's economy (Kumaraswamy, 2006). However, it also contributes to negative implications especially to the environment and social aspect of a country. In addition, the industry is always facing chronic problems such as time overrun, cost overrun, waste generation (Hussin, Rahman, & Memon, 2012a), poor safety (Nahmens & Ikuma, 2009), poor quality, excessive resource consumption and threat to environment (Hussin, Rahman, & Memon, 2012b).

2.2.1 Time Overrun

Achieving completion of construction projects on time is a basic requirement. However, seldom projects are completed on time. This has become a worldwide problem. A study showed that the Vietnamese government has acknowledged this issue as a serious concern, especially with government-related funded projects (Le-Hoai, Lee, & Lee, 2008). In Nigeria, out of 3,407 projects only 24 projects were completed on time, while 1517 were delayed and 1812 were abandoned (Amu & Adesanya, 2011). Omoregie & Radford (2006) reported that the minimum average percentage escalation period of projects in Nigeria was found to be 188%. A similar research was conducted in Bosnia and Herzegovina on 177 projects and found that the contracted date was not met in 51.40 % of the projects (Zujo, Car-Pusic, & Brkan-Vejzovic, 2010). Al-Momani (2000) conducted a survey on 130 public projects in Jordan and found delays occurred in 106 (82%) of the projects. Frimpong,

Oluwoye, & Crawford (2003) found that 33 (70%) out of 47 projects in Ghana were delayed. Whilst, in Saudi Arabia 70% of projects faced time delay with average time delay of 10% to 30% of the original duration of the project (Assaf & Al-Hejji, 2006).

Likewise in Malaysia also, the construction industry is facing the same critical problem of time overrun (Alaghbari, Kadir, Salim, & Ernawati, 2007; Ibrahim et al., 2010; Sambasivan & Soon, 2007). Abdullah (2010) reported that more than 90% of large MARA construction projects experienced delay since 1984. Endut et al. (2009) studied on time performance of 359 projects (301 new constructions while 58 refurbishment projects) in Malaysia. Of these 301 were public projects and 51 private projects. The study found that only 18.2% of the public sector projects and 29.45% of private sector projects had 0% time deviation (no delays) while the average percentage of time overrun for other projects was 49.71%. Time Delay can be due to one or more reasons including problems of financing and payment for completed works. As an example, Yogeswaran, Kumaraswamy, & Miller (1998) scrutinized 67 civil engineering projects in Hong Kong and found at least 15–20% of time overrun was due to inclement weather.

2.2.2 Cost Overrun

Cost is one of the major considerations throughout the lifecycle of a project. Unfortunately, most of the projects failed to achieve project completion with the estimated cost. Besides time overrun, cost overrun is also a serious problem in the construction industry. This is a major problem both in developed and developing countries. The trend is more severe in developing countries where these overruns sometimes exceeds 100% of the anticipated cost of the project (Azhar et al. 2008).

The history of the construction industry worldwide is full of projects that were completed with significant amount of cost overruns. Despite the wide availability and use of different project management methods and software packages, many construction projects still suffer cost overruns (Olawale & Sun, 2010). Developed countries have lessons to learn as well since cost overrun in the construction industry is a worldwide phenomenon (Ameh, Soyingbe, & Odusami, 2010). Approximately 90% of projects worldwide have cost overrun ranging from 50

to 100% of project cost (Flyvbjerg et al., 2003). Like other countries, Malaysian construction industry is also facing a lot of challenges in completing the construction projects within the estimated cost (Ibrahim et al., 2010; Toh et al., 2011) and more than 50% of projects face cost overrun (Endut et al., 2009).

2.2.3 Construction Waste

Waste is another serious problem in construction projects. Waste has direct impact on the productivity, material loss and completion time of project resulting in loss of a significant amount of revenue. Forsberg & Saukkoriipi, (2007) stated that the amount of waste contributed is around 30-35% of a project's production cost. The amount of construction materials wasted on the site is relatively high and equals 9% by weight of the purchased materials (Bossink & Brouwers, 1996). They investigated material waste generated in a Dutch construction project and found that the average waste per house was 6,860 kg which consisted of 4,480 kg of construction debris and 2,380 kg of other types of solid waste.

In Malaysia also construction waste generation is becoming an important issue (Begum, Satari, & Pereira, 2010; Nagapan, Rahman, Azis, Memon, & Zin, 2012). The high quantity of construction waste generated in the country is due to the rapid development of the construction industry. Demand of houses and major infrastructure projects contributed to the increase of construction waste (Nasaruddin, Ramli, & Ravana, 2008; Siti & Noor, 2008). Begum, Siwar, Pereira, & Jaafar (2006) studied the economic feasibility of waste minimization in Malaysian construction project and concluded that by adopting waste minimization strategy like recycling and reusing materials, it can save 2.5% of the total budget.

The major impact of increased construction waste generation has caused illegal dumping and has swelled rapidly in Malaysia (Yahaya & Larsen, 2008). A study done in Johor district alone indicated that 42% of 46 illegal dumping sites are of construction waste (Rahmat & Ibrahim, 2007). Furthermore, a study in Seberang Perai, Pulau Pinang also discovered more illegal dump site along the roadside (Faridah, Hasmanie, & Hasnain, 2004). Recent news had highlighted that almost 30 tons of construction wastes was dumped illegally in tropical mangrove swamp near

Bandar Hilir, Malacca (Murali, 2011) and construction debris problem near roadside at Section 17, Petaling Jaya, Selangor (Tan, 2012) as shown in figures 2.3 and 2.4.

Figure.2.3: Construction waste illegally dumped in mangrove swamp
Source: Murali (2011)

Figure.2.4: Construction debris along roadside. Source: Tan (2012)

These illegal dumping has caused a risk to human health and environment (Faridah et al., 2004; Rahmat & Ibrahim, 2007). The issues of illegal dumping arise is due to the cost and location of the project (Seow & Mohamad, 2007). The contractors intended to maximise profit by avoiding transportation cost and payment charge to the gazetted landfill. Distance between the project location and the landfill site also hinders the contractor to dispose in legal landfill. A study conducted at 30 construction sites in Malaysia identified six types of waste materials which includes concrete (12.32%), metals (9.62%), bricks (6.54%), plastics (0.43%), timber (69.10%) and other wastes (2%) (Faridah et al., 2004). Hence, it is timely for Malaysia to adopt a systematic and efficient waste management strategy which would minimise the generation of waste at different level. Advanced techniques such as lean construction can help in reducing waste at source and can minimised the waste produced during the operation by re-using and re-cycling.

2.2.4 Poor Safety

The construction industry is notoriously known for its poor safety record as compared with other industries (Mohamed, 2002). Poor safety resulted to accidents and fatality which affect significantly on efficiency and cost of the project. Accident

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